EFFECTS OF CORN OR CORN BY-PRODUCTS FED AS A PRE-BREEDING SUPPLEMENT ON BODY WEIGHT AND PREGNANCY IN RAMBOUILLET EWES

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ABSTRACT

The objectives of this study were to evaluate the effects of corn and dried distiller's grain fed as a prebreeding flushing supplement on weight gain and body condition, breeding and subsequent lambing rate, and early postnatal growth of Rambouillet ewes. Treatment groups consisted of 1 control group (n=30) that was not fed a supplement, 1 group (n=30) that was fed a corn based ration, and 1 group (n=30) that was fed a dried distiller's grain based ration. After the feeding period concluded, lamb data was collected to determine what, if any, change occurred. No differences ($p < 0.05$) were detected in body weight over time or on the number of ewes that conceived. However, significant differences ($p > 0.05$) were found in body condition score, number of lambs born, and 30 and 60 day weights of lambs. While flushing supplementation slowed down weight loss, there was no significant difference detected in reproductive efficiency.

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INTRODUCTION

Reproductive efficiency in the livestock industry is a driving factor of success in any livestock operation. The economic viability of any livestock operation is dependent upon the reproductive success of their animals. Feed inputs are generally one of the highest variable costs associated with a livestock operation (USDA 2017). Therefore, proper management of these two items are vital for success.

There are many different pathways that producers can utilize to increase their reproductive performance. Breeding strategies are a tool that a producer can use to manipulate management and improve an operation, however, reproduction is a lowly heritable trait (Bourdan, 2000). Given the generational intervals of different livestock species, change through selection can be slow.

Adjusting the nutritional plane of small ruminants can be a cost-effective means for short term improvements, and overall effective way of increasing reproductive efficiency. The relationship between nutrition and reproduction has been well documented for decades. The importance of nutrition encompasses the entire reproductive process, from gametogenesis to puberty, breeding to gestation, and parturition to raising, weaning, and rebreeding when the cycle starts again (Scaramuzzi et al., 2006).

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OBJECTIVES

The objectives of this study are to:

1.) Evaluate the effects of corn and dried distiller's grain on weight gain and body condition.
2.) Evaluate the effects of corn and dried distiller's grain on breeding and subsequent lambing rate.
3.) Evaluate the effects of feeding corn and dried distiller's grain on early postnatal growth.

LITERATURE REVIEW

While there are many different speculations as to what specifically results in an increase in reproductive efficiency, the common conclusion is that plane of nutrition plays a vital role. A major goal of flushing, regardless of ingredients used, is to increase the number of lambs born and weaned. Also, an increase in weight of lambs results in more pounds of product being sold in a commercial market (ASI, 2003).

Flushing

A popular method of achieving this increase in lambs produced and weaned is nutritional flushing. This is characterized by an increase in energy or protein supply two to three weeks prior to breeding, and two to three weeks during the first estrous cycle during the breeding period. The length of flushing period may vary with preference, but increasing the plane of nutrition is a key element of any regimen. The idea is not to replace diets but supplement during short intervals to obtain the desired success. Since an animal's first instinct is to survive, their maintenance nutrient requirement must be met before any nutrients to be diverted to reproductive purposes (ASI, 2003). The goal of flushing is to exceed the maintenance level to a point where the animal reaches a state of positive energy balance. Scaramuzzi et al., (2006) portrayed the relationship between nutrition and reproduction as an energy balance system. When the animal has less energy intake than energy requirement, the animal enters a state of negative energy balance. In this state, all non-necessary functions of the animal, including reproduction, are essentially shut down because the animal is not getting enough nutrients to provide for itself, much less producing, growing, and birthing another potentially two to three animals. This state of negative energy balance also contributes to longer postpartum intervals, longer anestrous periods, a decrease in concentration of LH levels, longer luteal phases, and weaker corpus luteum cells that produce less progesterone (Robinson et al., 2006).

Energy Source and Performance

The source of energy added to the diet can be achieved by many different combinations of different ingredients in different proportions. Corn is a source of energy, and it is normally an economically feasible commodity that is readily available in most areas (USDA, 2017). The most expensive part of any operation is feed cost and identifying alternative ingredients that will allow a less expensive means of energy supplementation will improve the efficiency of an operation. Speihs et al. (2002) and ADM (2017) describe in detail the process of making dried distiller's grain from corn, which results in the nutrient composition being increased threefold. Dried distiller's grains have been used as a protein supplement in many different research trials (Winterholler et al., 2012; Engel et al., 2008) involving cattle and showed positive growth rates when compared to more common protein sources, however the research directed as it being used as an energy supplement is more scarce. Milis and Liamadis (2008) report that performance is similar between corn gluten feed and corn as energy source on growing young lambs. However, Bowman and Paterson (1988) compared corn gluten feed to corn for growth in cattle and sheep and found that the there was little difference in growth rates (Scaramuzzi et al., 2006). The idea of flushing during the breeding season is to provide a slight excess in energy to result in the animal responding with maximum reproductive performance. Since this combination of corn gluten feed and dried distiller's grain is similar to corn in the amount of energy it supplies to the ruminant animal, the price of these flushing supplementations is going to be a driving factor in the usefulness and practicality of these methods.

There appears to be many factors that affect reproductive performance in livestock. Some of these factors include environmental conditions, stress, nutrition, anatomical deformities, and genetic influences (Bearden et al., 2004). Nutrition is not only an important factor to increase reproductive performance, it is a very easy variable to manipulate, also. Even though energy supplementation is not normally practical, when using it to improve conception and twinning in small ruminants, the cost should be below inputs and result a positive return. Additionally, there are multiple options for ingredient choice, which makes flushing an easy management option to implement. If any method or improvement is to be used, it must be economically efficient. This extends to the ingredients used, the amount of labor necessary to implement the methods, and the net profit made. Therefore, this study was designed to investigate the impact of DDG or corn as a source of energy for flushing on reproductive performance and subsequent lamb performance in Rambouillet ewes.

Effects of Protein and Energy on Various Reproductive Aspects

Various forms of energy in feed stuffs are responsible for many reproductive physiology changes in small ruminant animals. Of these changes, fetal growth, conception rate, and ovulation rate all have a significant impact on this research. Research across the years has pointed towards a correlation between increasing protein and energy in feedstuffs and an increase in ovulation rate in animals that ovulate multiple times (Land and Robinson, 2013). Increasing reproductive efficiency has been seen in various trials where levels of both energy and protein have varied throughout, so narrowing down a specific reason is increasingly difficult.

An increase in protein levels past a certain threshold has resulted in a hostile uterine environment, which results in less successful pregnancies. The threshold varies from trial to trial, but when protein gets too high, it increases the blood nitrogen and urea levels. This increase in urea levels leads to a change in the uterine pH level from neutral, which is desired to conceive and maintain any eventual pregnancies, to a more acidic condition which is not ideal (Grant et al., 2014, Salisbury et al., 2000, Smith, 1988). Increasing protein also has negative effects in the ability of follicles becoming dominant and eventually ovulating, and producing enough progesterone to maintain pregnancy as well.

Conception rate is also directly affected by nutrition. In a negative energy balance situation, longer postpartum intervals occur. This means an increased time between giving birth and rebreeding. This can be caused by a decreased body condition, and can result in reduced probability of conception (Robinson et al., 2006). A potential benefit of short term flushing with an energy source could reduce the length of postpartum intervals by bringing body condition scores up right before mating, hopefully increasing conception rates.

Smith (1988) described and evaluated the effect and influence of nutrition on the ovulation rate in ewes. He discovered that with a fewer number of large follicles compared to total follicle numbers at slaughter resulted in fewer follicles actually ovulating.

MATERIALS AND METHODS

The location of this study was the Angelo State University's Management, Instruction and Research Center in San Angelo, Texas in Tom Green County. All procedures and management were approved by the Institutional Animal Care and Use Committee, approval number 16-08. This study utilized 90 mature Rambouillet ewes varying in age of 3 to 5 years and all had lambed the previous breeding season. Ewes were kept in a pasture setting and brought up 5 days a week to a pen setting where the supplement was fed. The ewes were separated into 3 different groups; a corn based supplemental ration (CORN), a dried distiller's grain based supplemental ration (DDG), and a control group (CON) that are not fed a supplement that is the control group. These supplements (Tables 1 & 2) were fed at a rate of 0.65 kg/head/day.

After an adaptation period of approximately 14 days, all ewes were moved to the same pasture. The site is characterized as a relatively flat, moderately deep clay loam soils. Vegetation consists of an over-story of mesquite (*Prosopsis glandulosa*) and an under-story dominated by a mixture of mid- and short-grasses. Common mid-species consist of sideoats grama (*Bouteloua curtipendula*), kleingrass (*Panicum coloratum*), silver bluestem (*Bothriochloa laguroides*) and old world bluestem (*Bothriochloa ischaemum*). Common short-grasses include a mixture of buffalograss (*Buchloe dactyloides*), red grama (*Bouteloua trifida*), Hall's panicum (*Panicum hallii*), and fall witchgrass (*Digitaria cognata*). On Day 0 all ewes were weighed (kg), assigned a body condition score (BCS) and randomly assigned into the three different groups with 30 ewes in each group. The body condition scores were determined by two evaluators on a 1 to 5 scale, 1 being extremely emaciated and 5 being

Table 1. Supplement percentages of experimental diets fed to Rambouillet ewes pre-breeding as an energy flush.

	Treatment, %	
Ingredient	Corn	DDG[1]
Corn	51.0	20.0
Dried Distillers Grain	0.0	18.5
Corn Gluten Feed	0.0	18.5
Cotton Seed Hulls	31.5	25.0
Alfalfa Pellets	12.0	12.5
Molasses	3.0	3.0
Premix	2.5	2.5

[1]DDG= Dried distillers grain.

Table 2. Nutrient composition of experimental diets fed to Rambouillet ewes pre-breeding as an energy flush.

	Treatments	
Nutrient, As Fed	Corn	DDG[1]
NEm, Megcal/CWT	57.48	57.71
NEg, Megcal/CWT	36.48	36.29
TDN, %	58.10	57.31
Fat	3.47	4.78
Crude Fiber	16.88	16.54
ADF	23.81	24.06
NDF	31.86	36.49
eNDF	43.73	35.40
Crude Protein, %	9.75	15.97
Potassium, %	0.87	1.10
Calcium, %	0.70	0.75
Phosphorus, %	0.24	0.46
Magnesium, %	0.16	0.24
Sulfur, %	0.13	0.28
Cobalt, ppm	0.46	0.52
Copper, ppm	4.57	5.37
Iron, ppm	150.85	175.49
Manganese, ppm	43.93	49.93
Selenium, ppm	0.24	0.31
Zinc, ppm	62.42	80.67

[1]DDG= Dried distillers grain.

obese, and a mean score was recorded. The body condition score system that was used is described in the American Sheep Production Handbook (ASI, 2003). The ewes were weighed and assigned body condition scores 3 more times throughout the first half of the project (Table 3). These weigh days were 3 weeks after supplemental feeding began, 3 weeks after rams were turned out, 3 weeks after supplemental feeding stopped, and marking harnesses were placed on rams after the initial breeding cycle (Table 3).

Ewes were rotated between different pastures on d 46. So that they were in the same pasture for the first two weigh periods which corresponded to the feeding period, and on the third period, they were moved to an adjacent pasture to avoid an overgrazing situation of any one pasture. The pastures were all similar in forage selection, quality, and quantity.

Following the supplementation and breeding periods, all ewes were maintained in a native range pasture until lambing. At lambing, ewes were checked for udder development and once determined they are relatively close to parturition, approximately one week, they were relocated to a facility situation for data collection and care during lambing. Once lambs were born, number of lambs born to each ewe, date of birth, birth weight of each lamb, and which treatment group each ewe belonged to were recorded. All lambs were identified with an ear tag and recorded. Lambs and ewes were kept in pen setting for approximately 10 days where lambs were vaccinated with Clostridium Perfrigens type C & D and tetanus, and tails docked using the elastrator method. After lambs were worked, they were given 3-5 days to recover before being moved with their mothers to an oat field where they were supplemented with a high magnesium mineral and allowed free access to water. Adjusted lamb weights

Table 3. Data collection timeline.

Day:	Event:
-11	All ewes moved to same pasture for adaptation period
0	Initial data collection day, random assignment of ewes to treatment groups, initial weight and BCS assigned, began supplemental feeding
25	2nd data collection day, rams were introduced
46	3rd data collection day, supplemental feeding was stopped, marking harnesses put on rams, ewes and rams were moved into adjoining pasture
68	4th and final data collection day, marks from rams' harnesses were recorded

were also recorded at approximately 30 and 60 days after birth to observe if maternal nutritional plane had any long-term effects on lamb performance.

Data collected was compared among treatments and periods within treatment. Variables measured were day 0, 25, 46, and 68 body weights and BCS. Breeding harness marks were recorded between day 46 and 68 to determine breeding during conception during the first cycle following the treatment impacts.

Mixed model procedures of SAS (SAS Inst. Cary, NC) were used to evaluate ewe body weight, ewe body condition scores, and lamb weight data with day and diet as fixed effects, and the day by diet interaction. These models were analyzed as repeated measures with an unstructured covariance model type. Least squares means were reported and estimates were considered different at $P \leq 0.05$ using the pdiff option.

RESULTS

Ewe Body Weight

Body weight, kg, was not different (*P* > 0.05) among treatments at the beginning of the study (Table 4). This suggests that ewes were evenly distributed during experiment development. Throughout the trial, there was no differences across time in body weight changes between the treatment groups or the control group. All groups lost weight over time, however both the DDG and CORN groups lost less weight than the control group. This suggests that a flushing supplementation, regardless of energy source, was slowing weight loss over time. This is in agreement with the NRC (2007) and other research (Salisbury et al., 2000) that suggests feeding a flushing supplement will slow down weight loss over time.

Ewe Body Condition Score

Body condition score on a 1-5 scale was not different (*P* > 0.05) among treatments at the beginning of the study (Table 5). This suggests that ewes were evenly distributed during experiment development. However, after only 25 d of feeding the energy supplement, the ewes receiving the supplement, regardless of energy source, were higher (*P* < 0.05) in their score when compared to the control, but were similar between the supplementation treatments. At d 46 treatments were not different (*P > 0.05*). The trend continues to the conclusion of the experiment where at d 68 both supplementation treatments were higher (*P* < 0.05; Table 4) than the control. Therefore, supplementing with an energy source will

Table 4. Ewe body weights (kg) when supplemented with a diet containing corn or distillers dried grains while grazing native pasture.

	Treatments[a]			
Day	CON[b]	DDG[c]	CORN[d]	SEM[e]
Day 0	73.3[f]	73.7[f]	72.5[f]	1.80
Day 25	69.1[g]	73.3[f]	70.6[f]	1.69
Day 46	69.9[g]	72.0[f]	70.4[f]	1.58
Day 68	67.3[g]	69.5[g]	68.5[g]	1.56

[a]Treatments are not different, ($P > 0.10$).
[b]CON = control, ewes received no supplement
[c]DDG = supplement containing distillers dried grains as the energy source
[d]CORN = supplement containing corn as the energy source.
[e]SEM = standard error of the least squares mean.
[f,g] Means in the same column with differing superscripts are different ($P < 0.05$).

Table 5. Ewe body condition score (1-5) when supplemented with a diet containing corn or distillers dried grains while grazing native pasture.

Day	Treatments[a]			
	CON[b]	DDG[c]	CORN[d]	SEM[e]
Day 0	2.48[f]	2.58[f]	2.57[f]	.12
Day 25	2.52[f]	2.90[g]	2.93[g]	.12
Day 46	2.68[f]	2.85[f]	2.84[f]	.09
Day 68	2.65[f]	2.94[g]	2.86[g]	.08

[a]Treatments are not different, ($P > 0.10$).
[b]CON = control, ewes received no supplement
[c]DDG = supplement containing distillers dried grains as the energy source
[d]CORN = supplement containing corn as the energy source.
[e]SEM = standard error of the least squares mean.
[fg] Data in rows with different superscripts differ, ($P < 0.05$).

improve ewe body condition scores. This is in agreement with the NRC (2007) where it is suggested that providing a short-term energy supplement will result in a slight increase in body condition, which is the intention of flushing.

Lamb Production

The number of ewes in each treatment group that conceived in the first 42 days after supplementing began (Table 6) were similar across the treatment group and control group. However, the average number of lambs born in each group were varied. There was no difference ($P > 0.05$) between the average number of lambs born in the control group and the DDG treatment group. The CORN group was higher ($P < 0.05$) than both the control and DDG groups.

Lamb Weights

Birth weights for lambs were not different ($P > 0.05$) between the treatment and control groups (Table 7) suggesting that feeding a flushing supplementation, regardless of energy source, did not have an impact on initial birth weights. Day 30 and day 60 weights did show a difference between the groups, though. The CON was different ($P < 0.05$) than DDG group, but not different ($P > 0.05$) than the CORN group. The CORN group did not differ ($P > 0.05$) from either the CON and DDG groups on either the 30 or 60 day weights. This could mean that there were more twins born to the DDG group, or that the weights of individual lambs were heavier.

Table 6. Lamb production per group when supplemented with a diet containing corn or distillers dried grains while grazing native pasture.

	Treatments[a]		
	CON[b]	DDG[c]	CORN[d]
Lambs Born[e]	27[f]	21[f]	16[g]
Ewes Conceived[h]	14	12	12

[a]Treatments are not different, ($P > 0.10$).
[b]CON = control, ewes received no supplement
[c]DDG = supplement containing distillers dried grains as the energy source
[d]CORN = supplement containing corn as the energy source.
[e]Lambs Born = average number of lambs born in each group

[f,g] Data in rows with different superscripts differ, ($P < 0.05$).

[h]Ewes Conceived = ewes conceiving during the first 42 days of breeding season

Table 7. Lamb production per group when supplemented with a diet containing corn or distillers dried grains while grazing native pasture.

	Treatments[a]			
Day	CON[b]	DDG[c]	CORN[d]	SEM[e]
Day 0[f]	9.92	9.91	10.0	.39
Day 30[g]	14.13[h]	19.02[i]	15.83[hi]	1.81
Day 60[j]	17.36[h]	23.00[i]	18.29[hi]	2.13

[a]Treatments are not different, ($P > 0.10$).
[b]CON = control, ewes received no supplement
[c]DDG = supplement containing distillers dried grains as the energy source
[d]CORN = supplement containing corn as the energy source

[e]SEM = standard error of the least squares mean.
[f]Day 0 = birth weight, kg

[g]Day 30 = average weight of lambs on day 30, kg

[j]Day 60 = average weight of lambs on day 60, kg

[h,i] Data in rows with different superscripts differ, ($P < 0.05$).

DISCUSSION AND IMPLICATIONS

Under current experimental conditions, it was determined that the flushing supplementations were of limited benefit to feed. All groups lost weight over time, resulting in potentially less conception rates and subsequently less lambs and kilograms of lambs born. However, the DDG and CORN treatment groups lost less weight overall than the CON group, which leads to suspicions of uncontrollable variables having insurmountable effects. Some potential variables that could lead to the weight loss and overall decrease in conception rate of all ewes could be the initial body condition score of the ewes, forage quality, forage quantity, stress, and metabolic health. In order for flushing to be effective, ewes must be of suboptimal condition (American Sheep Industry, 2003). On a scale of 1-5 (1= extreme emaciation and 5 = extreme obesity), ewes should be below a 2.5 and ewes on this study never fell below a 2.5 which could explain the lack of benefit to the supplement (Robinson et al., 2006).

Body weights in the current study showed that all ewes lost body weight indicating that total nutrient intake was not sufficient for maintenance at their current body weight. However, the supplementation groups' weight loss was curtailed indicating the supplements were providing benefit. This phenomenon was most likely the result of tremendous forage growth during the growing season, resulting in decreasing forage quality from large, mature stands of forage. Unfortunately, this condition was not anticipated and forage quality data was not collected for the current study.

Yet, should the data collection been extended, it is likely the weight loss in the supplementation groups would have reached a point where it was providing maintenance energy levels (NRC, 2007). This further explains the reason flushing at higher body condition is not beneficial. It becomes difficult to impact the ewe enough at a higher body condition to make her, metabolically, consider herself at an increasing plain of nutrition. This was evident in a study conducted by Salisbury et al. (2000) where they supplemented energy as a pure corn start or high fat soybean oil to ewes in sub optimal body condition and exhibited an increase in total lambs born and subsequently total lamb production per ewe. However, similar to the current study, Coley (2011) found no benefit to energy supplementation to cows when they were relatively adequate in body condition at the time of supplementation.

As with any production research project, efforts are taken to minimize stress and disruption to normal daily routines of the animals. The same is true in the current study. The ewes were allowed an adaptation period and they were grazing familiar pastures. They were also supplemented in facilities they were familiar with, but regardless of the effort to minimize stress and disruption to normal activities it will be disrupted and inevitably cause stress. Since blood cortisol levels were not measured, it is difficult to quantify the amount of stress the ewes were under (Fraser and Broom, 1990). While every effort was made to limit daily stress of animals for both animal safety and research quality, stress was unavoidable. The two pastures that were used are roughly the same size (~167 ac and ~172 ac) and both an equal distance from the working facilities, but depending on where the group was in the pasture, the distance ewes had to traverse across the pasture to get to the working facilities. They also had to be worked through the sorting chute and sorted into their treatment groups for feeding every day, which caused assumed stress and an extended period of time for them to calm down before they could be fed. Some days, particularly the rainy days and humid and hot days, the ewes took longer to calm down and longer to eat. With any type of animal handling, any elevated stress will often result in accelerated weight loss or decreased weight gain. Unfortunately, the daily handling may have created such a case.

It is established that the ewes had weight loss but it was not severe and supplementation should have still resulted in an advantage for conception. There is a tendency for the CON treatment to have a slight advantage in lamb numbers which is interesting because they received no supplementation and had a higher weight loss. Thus, we can speculate that the supplementation levels fed to the ewes might have actually resulted in a substitution effect (NRC, 2007) resulting in reduced forage intake. If this were the case, then according to Church (1993) the rumen environment may have been actually less healthy. High levels of protein, whether escape or rumen degradable, can create a more acidic environment in the uterus resulting in lower conception rates and ultimately less total lambs produced (Smith, 1988). Therefore, supplemental diet intake along with forage quality might have impacted the ewes' ability to reproduce, regardless of weight gain or loss.

The current study showed no advantage to flushing supplementation in Rambouillet ewes grazing native pasture on lamb production. Unfortunately, as in most extensively managed production research projects, uncontrollable environmental factors have a tremendous impact and this study was no different. Even though energy supplementation was provided, which in normal circumstances is not needed, to create a phenomenon of increase plain of nutrition scenario it did not happen. This was due to an unmeasured and unidentified variable. Therefore, the next phase of the research must be focuses on the control and elimination of extraneous factors that impact production variables as well as observe the condition of the ewes to determine if supplementation of energy would result in a benefit based on published data. Though difficult to plan for, a balance of diet protein with forage protein should be considered when establishing a supplement for flushing.

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VITA

Savannah Elizabeth Clay was born January 28, 1993 in San Angelo, Texas to John and Torrey Clay. The author was raised in San Angelo and graduated from Central High School in May 2011. Savannah attended Angelo State University from August 2011 to May 2015 and obtained a Bachelor of Science Degree in Animal Science in May 2015. The author was admitted to the Graduate School at Angelo State University in July 2015 and began working towards her Master of Science Degree in Animal Science the following August.

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ANGELO STATE UNIVERSITY

College of Graduate Studies & Research

Institutional Animal Care & Use Committee

June 27, 2017

Micheal W. Salisbury, Ph.D.
Chair, Department of Agriculture
Director, Management Instruction and Research Center
Professor of Animal Science
Angelo State University

Dear Dr. Salisbury:

Your proposed project titled, "*Effect of feeding corn gluten feed as a prebreeding supplement to ewes*" was reviewed by Angelo State University's Institutional Animal Care and Use Committee (IACUC) in accordance with the regulations set forth in the Animal Welfare Act and P.L. 99-158.

This protocol was approved for three years, effective September 11, 2016, and it expires three years from this date; however, an annual review and progress report form (www.angelo.edu/content/files/22583-iacuc-annual-review-progressreport) for this project is due on August 15 of each year. If the study will continue beyond three years, you must submit a request for continuation before the current protocol expires.

The protocol number for your approved project is #16-08. Please include this number in the subject line of in all future communications with the IACUC regarding the protocol.

Sincerely,

Chase A. Runyan, Ph.D.
Co-Chair *Elect*, Institutional Animal Care and Use Committee

Dr. Robert Dowler, IRB Chair | ASU Station #11025 | San Angelo, Texas 76909
Phone: (325) 486-6639